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# **Toward Adopting a Nationwide Health Information Network (NHIN): Promises and Challenges**

## **Abstract**

*The future of the U.S. health care system has been the subject of heated debates prior to almost every recent U.S. presidential election. The United States is the only industrialized country that does not provide nationwide health coverage to all its citizens. In addition, the U.S. health care system has to face other challenges. In a 1999 study, it was estimated that between 44,000 and 98,000 American die each year from medical error and inappropriate treatment.*

*Adoption of Electronic Health Records (EHR) systems can extend the efficiencies and effectiveness of health care services in health professionals' offices and improve the health care quality for patients. An important issue in using EHRs in different health care organizations is the exchange of information and data sharing among different EHR systems.*

*The major problem facing the U.S. health care system is the integration of health information to construct a large-scale 'network of networks'. Health care organizations throughout the nation have recognized the importance of a transition from the current highly fragmented and disconnected health care information system to a secure and reliable nationwide health care information network for sharing critical health information at the point the clinical decision has to be made. The main goal of Nationwide Healthcare Information Network (NHIN) is to develop a secure, reliable, and interoperable infrastructure that all patients, healthcare providers, and other health care related organizations -like health insurance companies, public health centers, and health care research institutes- will be able to create, update and access the health information they need, at the time, and in the form that is useful regardless of the origin of data.*

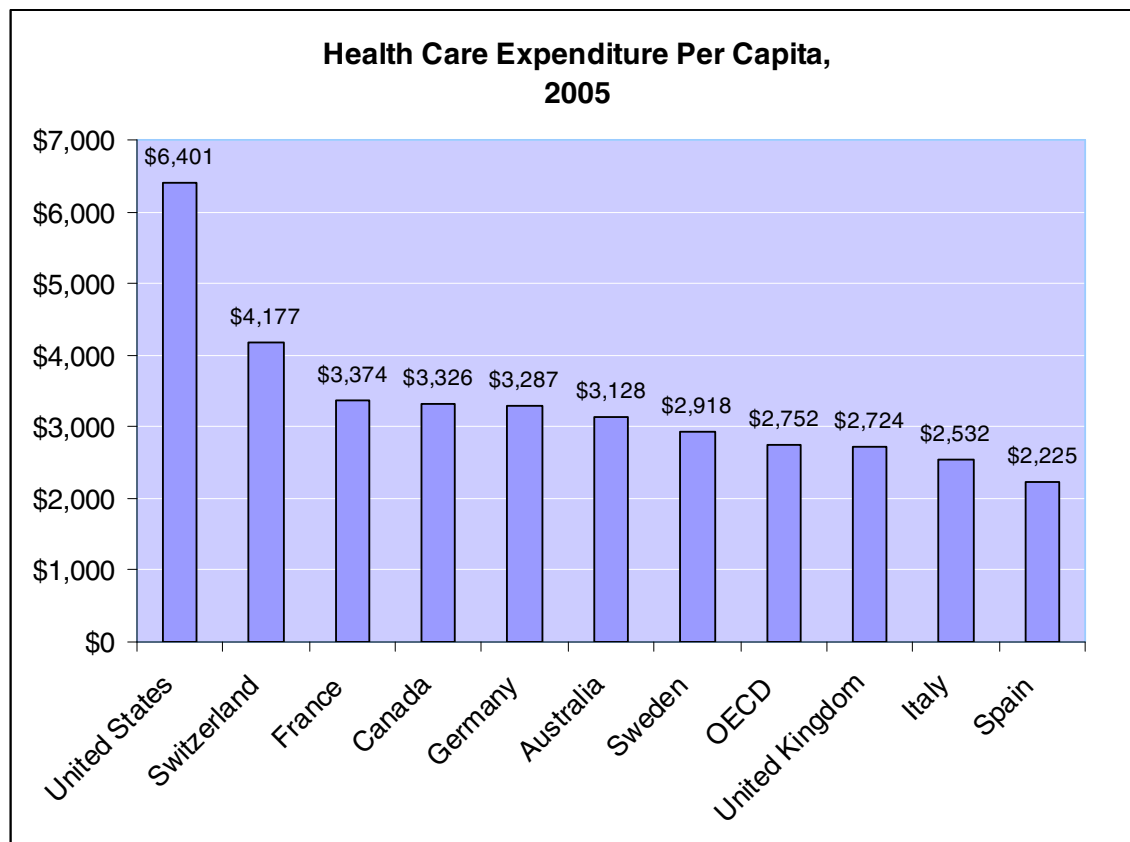
**Keywords:** Health care, EHR, NHIN, Information integration, Interoperability

## **Introduction:**

The future of the U.S. health care system has been the subject of heated debates prior to almost every recent U.S. presidential election. According to a national opinion survey conducted during the 2004 presidential campaign – at the time that the United States was actively engaged in wars in Iraq and Afghanistan - health care was the fourth most important issue that American voters were concerned about in deciding their vote. The results of the survey suggest that 62 percent of voters were disappointed with the accessibility and affordability of the health care system in the U.S. [1]

According to “*OECD health data 2006*” report, the United States is the only country among the 23 industrialized countries that does not provide nationwide health coverage to all its citizens. The high cost of health care and drug prescription, the lack of universal health insurance, and the large number of deaths from medical errors are the three major issues at the heart of what has been called the U.S. health care crisis.

The growth of national health care spending in the United States, in 2005, was 7.0 percent - more than twice the rate of inflation (2.68%) and higher than the U.S. gross domestic product’s (GDP) growth (3.9%). Total U.S. national health expenditure also in 2005 amounted to \$1.86 Trillion and is expected to reach \$4.00 Trillion or 20 percent of GDP, by the year 2015 [2]. To put these numbers in context, refer to Figure 1 which displays health care expenditures per capita in selected OECD countries in 2005.



**Figure 1- Health care expenditure per capita in selected OECD countries, 2005**

*Source: OECD Health Data 2007: Statistics and Indicators for 30 Countries*

While the United States has been recognized as possessing one of the most advanced health care systems amid developed countries, both the percentage and the number of people without health insurance have increased in 2006. Approximately 47.0 million of Americans are living without health insurance and are not able to use the health care services when they need them [3].

In 2000, The World Health Organization (WHO) published a report with health information for 191 member countries. In this report WHO defined three criteria for recognizing a good health care system:

- Good health status for the whole population
- Responsiveness
- Fairness in financing the health system

While the cost of health care services, in 2000, was \$1.4 Trillion, or 13.8 percent of the U.S. GDP, higher than any other country in the world, the WHO report indicates that the U.S. ranked 37 out of 191 countries based on the health system’s overall performance [4].

In addition, the U.S. health care system has to face other challenges. In a 1999 study by the National Academy of Sciences' Institute of Medicine, entitled "*To Err Is Human: Building a Safer Health Care System*", it was estimated that between 44,000 and 98,000 American die each year from medical error and inappropriate treatment [5]. The report referred to two large studies, one conducted in Colorado and Utah and the other in New York, and concluded that "Even when using the lower estimate, deaths in hospitals due to preventable adverse events exceed the number attributable to the 8th-leading cause of death. Deaths due to preventable adverse events exceed the deaths attributable to motor vehicle accidents (43,458), breast cancer (42,297) or AIDS (16,516)."[6] A more recent report suggested that the number of deaths from medical errors in the U.S. hospitals can run as high as 195,000 a year. The report calculated that from 2000 to 2006 over 575,000 avoidable deaths occurred, as a direct result of the 2.5 million patient safety incidents [7].

## Historical Background and Antecedents

On April 27, 2004, President George W. Bush signed Executive Order #13335 which created incentives for the use of Health Information Technology and established the position of the National Health Information Technology Coordinator, within Department of Health and Human Services (HHS).

According to the President's Executive Order, "The work of the National Coordinator shall be consistent with a vision of developing a nationwide interoperable health information technology infrastructure that:

- (a) – Ensures that appropriate information to guide medical decisions is available at the time and place of care;
- (b) – Improves health care quality, reduces medical errors, and advances the delivery of appropriate , evidence-based medical care;
- (c) – Reduces health care costs resulting from inefficiency, medical errors, inappropriate care, and incomplete information;
- (d) – Promotes a more effective marketplace, greater competition, and increased choice through the wider availability of accurate information on health care costs, quality, and outcomes;
- (e) – Improves the coordination of care and information among hospitals, laboratories, physician offices, and other ambulatory care providers through an effective infrastructure for the secure and authorized exchange of health care information; and
- (f) – Ensures that patients' individually identifiable health information is secure and protected." [8]

In July 2004, to implement the Executive Order #13335, HHS released the Framework for Strategic Action, which outlined four major goals [9]. Each goal is supported by three policies and strategies as shown in Table 1:

Adoption of EHR systems can extend the efficiencies and effectiveness of health care services in health professionals' offices and improve the health care quality for patients. According to American Hospital Association Report, entitled "*Continued Progress, Hospital Use of Information Technology*", in 2006, only 11 percent of hospitals in the U.S. had fully implemented EHRs. While the acceptance and implementation of EHRs have been increasing gradually, 32 percent of U.S. hospitals have still not adopted EHRs and continue to rely on paper based systems [10].

An important issue in using EHRs in different health care organizations is the exchange of information and data sharing among different EHR systems. Since EHRs are developed and marketed by different vendors, in the absence of common integration standards and protocols, they may not be compatible with one another. Hence, when a health care service provider has implanted its own EHR system, it creates an '*island of information*' that may not be conducive to effective communication, exchange of medical data, and integration with other electronic health care systems. Without the ability of data sharing and information exchange across a region or throughout the country, patients' information cannot be available when and where needed.

In November 2004, the U.S. Department of Health and Human Services (HHS) initiated a Request for Information (RFI) to design and develop a nationwide health information network (NHIN) to connect all health care services. The main goal was to create architecture for national health information integration and exchange, especially information contained in Electronic Health Records (EHRs).

**Table 1- HHS Framework for Action: Goals and Strategies**  
*Source: Health Information Technology- Summary of Strategy Framework*

Goal	Strategies
Inform Clinicians	<ul style="list-style-type: none"> <li>• Provide incentive for Electronic Health Records (EHRs) adoption</li> <li>• Reduce risk of EHR investment</li> <li>• Promote EHR diffusion in rural and underserved areas</li> </ul>
Interconnect Clinicians	<ul style="list-style-type: none"> <li>• Foster regional collaboration</li> <li>• Develop a national health information network</li> <li>• Coordinate federal health information systems</li> </ul>
Personalize Care	<ul style="list-style-type: none"> <li>• Encourage use of Personal Health Records (PHRs)</li> <li>• Enhance informed consumer choice</li> <li>• Promote the use of telehealth systems</li> </ul>
Improve Population Health	<ul style="list-style-type: none"> <li>• Unify public health surveillance architecture</li> <li>• Streamline quality and health status monitoring</li> <li>• Accelerate research and dissemination of evidence</li> </ul>

In response to the Office of the National Coordinator’s RFI, five hundred and twelve individuals and organizations submitted proposals. These were suggestions about NHIN architecture and how it could be implemented, operated, and maintained. The results of the RFI were used to provide information about feasible solutions through which health care data could be shared, exchanged, and integrated nationwide on a sustainable foundation [11].

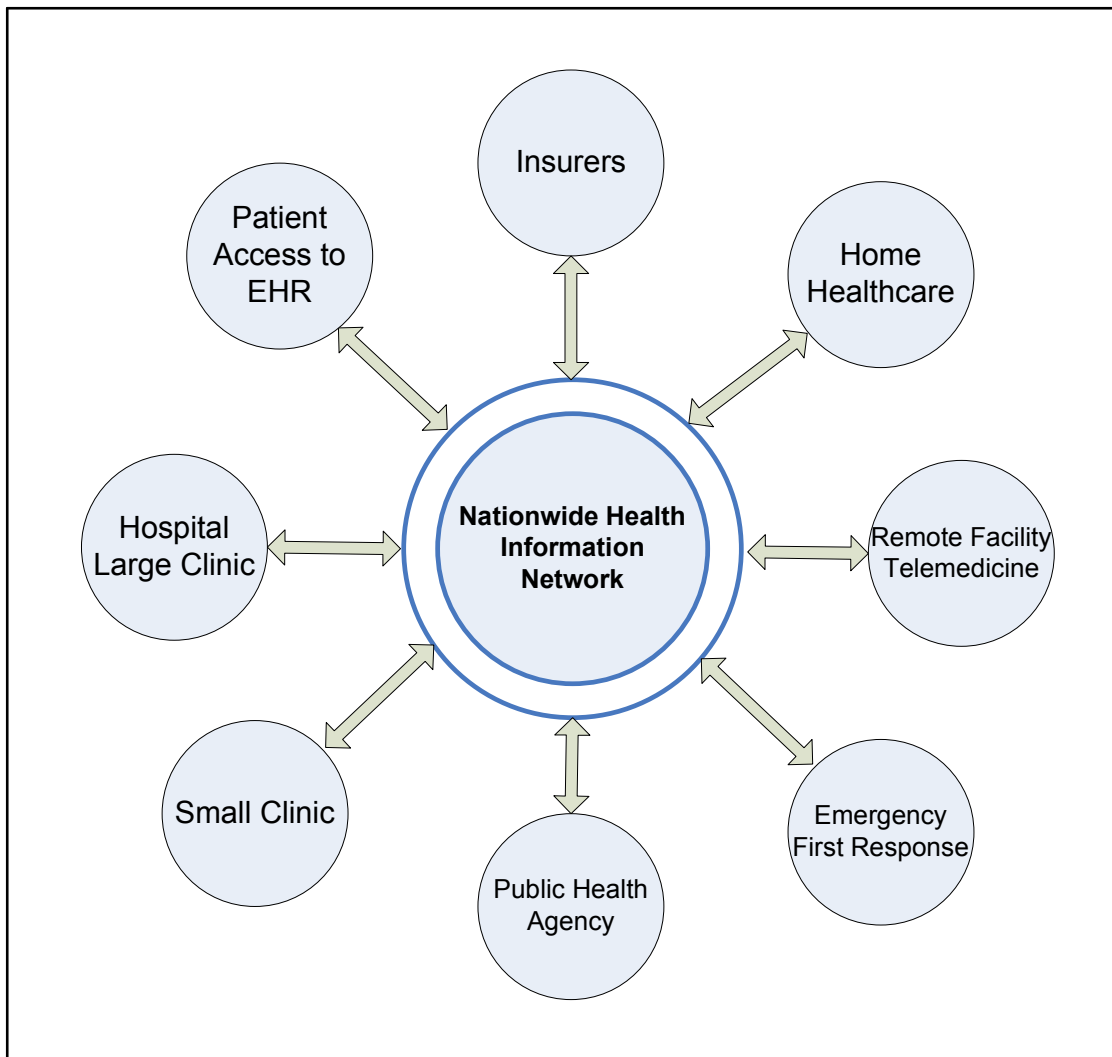
A Federal government Review Task Force (RTF), formed by the Office of the National Coordinator for Health IT(ONC), reviewed both individual responses and organizational responses and on November 10, 2005, the HSS Secretary proclaimed the award of contracts to four group of health information technology organizations, including *Accenture*, *Computer Science Corporation (CSC)*, *International Business Machines (IBM)* and *Northrop Grumman*. These companies were awarded a total of \$18.6 million in contracts to develop prototypes for a nationwide health information network (NHIN) infrastructure [12].

The purpose of developing NHIN prototypes is to explore how Americans’ health information can be securely exchanged and how NHIN can improve the U.S. health care system through higher quality, fewer medical errors, and lower cost.

## What is NHIN?

The major problem facing the U.S. health care system is the integration of health information to construct a large-scale ‘*network of networks*’. Health care organizations throughout the nation have recognized the importance of a transition from the current highly fragmented and disconnected health care information system to a secure and reliable nationwide health care information network for sharing critical health information at the point the clinical decision has to be made.

The main goal of Nationwide Healthcare Information Network (NHIN) is to develop a secure, reliable, and interoperable infrastructure that all patients, healthcare providers - including hospitals, clinics, public health facilities, clinicians, medical laboratories - , and other health care related organizations -like health insurance companies, public health centers, and health care research institutes- will be able to create, update and access the health information they need, at the time, and in the form that is useful regardless of the origin of data [13]. Figure 2 displays the functions and participants of the Nationwide Health Information Network (NHIN).



**Figure 2- National Health Information Network functions and participants**

## **Benefits of NHIN**

The following benefits will be available for all of health system participants by adopting and implementing the health care information sharing, exchange, and integration through NHIN.

- Provide high quality healthcare
- Provide access to EHR and PHR
- Reduce the number of medical errors
- Eliminate duplicate treatments and medical tests
- Decrease health care costs
- Provide continuous access to health information
- Provide the opportunity for telemedicine and telehealth
- Make available online claim processing

## NHIN Requirements

The requirements for NHIN infrastructure are intensive and complex. Most of the requirements that the NHIN infrastructure must address and support are listed below

- The NHIN architecture should have a decentralized structure. It should not contain a central IT decision-making management, central data storage, or dedicated services and procedures.
- The NHIN architecture must recognize the existence of numerous independent healthcare organizations including clinicians' offices, hospitals, large and small clinics, public health agency, and nursing homes.
- The NHIN architecture should support information sharing, exchange, and integration across health care organizations with different workflow, and regulations.
- The NHIN information sharing, exchange, and integration must occur among data sources that differ widely in software, hardware architecture, and communication infrastructure.
- The NHIN infrastructure design must be dynamic, capable of evolving as the information sharing requirements change and the technology is transformed.

## NHIN Interoperability Considerations

The Institute of Electrical and Electronics Engineers (IEEE) Standard Computer Dictionary, published in 1990, defines “*interoperability*” as “the ability of two or more systems or components to exchange information and to use the information that has been exchanged”. Interoperable information systems communicate with each other on an ongoing basis despite different purposes, structures, and underlying technologies.

While the interoperability in health information systems will make possible health quality, efficiency, and effectiveness of treatments, nonetheless, there are many obstacles and barriers to health information sharing including:

- lack of agreement between participants to share information
- lack of agreement on standards for secure exchange of information
- lack of agreement on how to identify patients across the nationwide health information networks.
- lack of agreement on how to deal with privacy and security breaches

To support disparate user groups and functions, interoperability becomes a critical requirement in developing NHIN. To ensure interoperability, numerous procedures and operations which are used in NHIN, such as accessing EHR, PHR, submitting health insurance claims, must be performed identically, at any point in the network, regardless of implementation.

The most important component of interoperability is defining different kind of standards at all levels of NHIN architecture including medical terminology standards, medical classification system, and HL7 electronic health record standards.

**Medical Terminology Standards** are used in clinical and laboratory Electronic Health Records (EHRs). Two major medical terminology standards are:

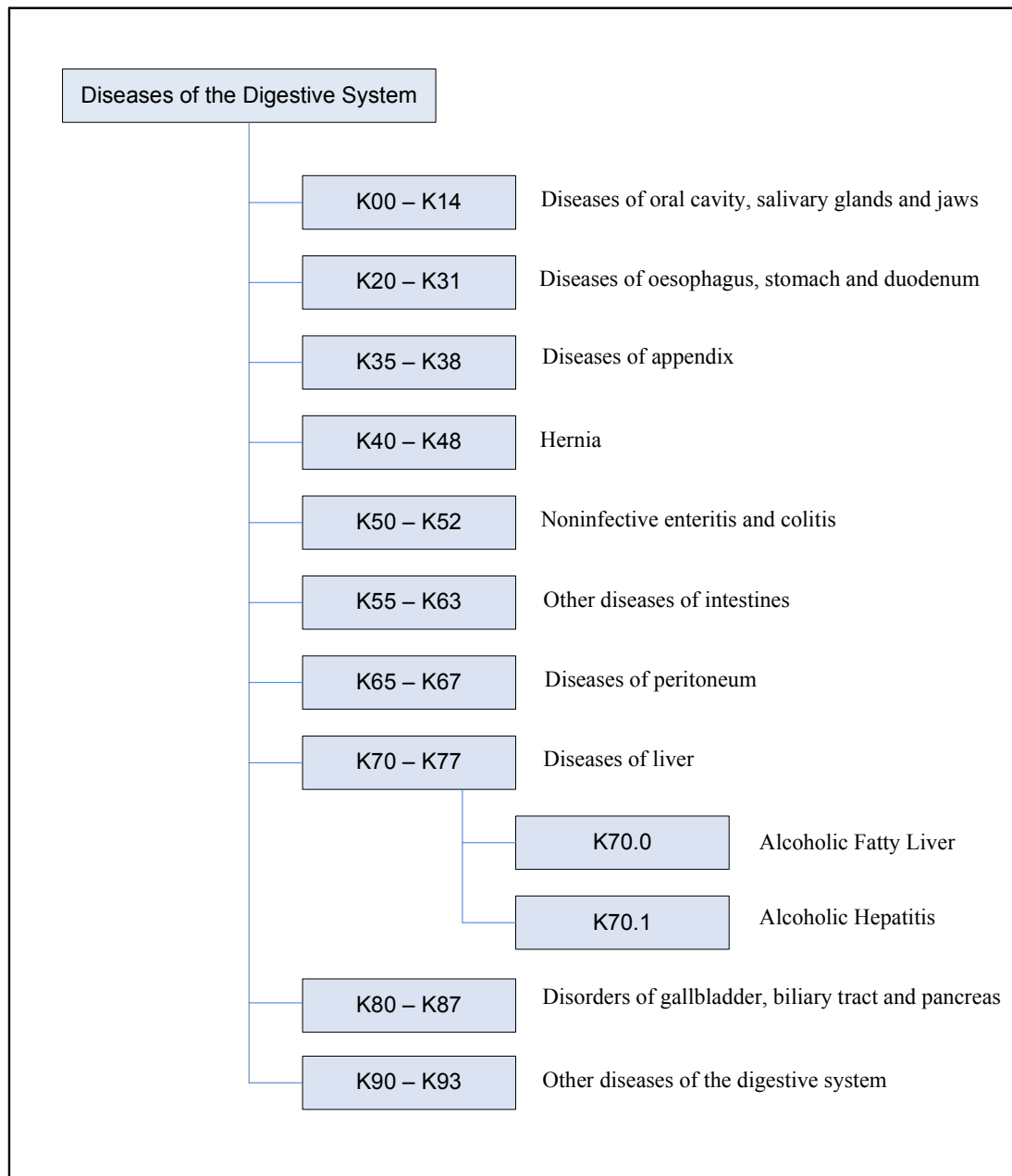
**SNOMED-CT** (Standardized Nomenclature for Medicine – Clinical Terminology), which provides the general terminology for the Electronic Health Record (EHR). Its database encompassing more than 350,000 terms constitutes the largest clinical terminology in the world.

**LOINC®** (Logical Observation Identifiers Names and Codes), which defines universal identifiers for laboratory and clinical observation. LOINC® standards are used for the electronic exchange of health information [14].

**Medical Classification Systems** provide uniform information about medical services and procedures between physicians, patients, and administrative and financial organizations. Medical classification is the process of transforming medical

procedures as reflected in physicians' notes or medical lab result reports into a standard encoding system. ICD and CPT are the two common medical classification systems.

**ICD** or the International Classification of Diseases provides classification codes for storing and retrieving diseases' records. The ICD category contains 22 different chapters that classify all mortality and morbidity information and assigns a unique code to each human health condition. ICD10 is the latest version of ICD maintained by the World Health Organization (WHO). Figure 3 displays all classified codes defined for diseases of the digestive system. In this classification each node by itself is the root of a much more detailed set of codes for specific digestive system diseases; for example K70.0 is the classification code used for "*Alcoholic fatty liver*" disease and K70.1 is the classification code for "*Alcoholic hepatitis*" [16].



**Figure 3- ICD10 - Chapter XI - Diseases of the Digestive System (Version for 2007)**  
**International Classification of Diseases and Related Health Problems**

*Source: World Health Organization, International Classification of Diseases*



**CPT** or Current Procedural Terminology is a collection of terms and codes that are used by clinicians for reporting medical, surgical, and diagnosis services and procedures. CPT codes are defined and maintained by the American Medical Association (AMA). Following is an example of a medical report which lists medical services provided including corresponding CPT codes [15].

- Interpretation of cardiac output measurements (CPT 93561, 93562);
- Chest X-rays (CPT 71010, 71020);
- Blood gases;
- Blood draw for specimen (HCPCS G0001);
- Information data stored in computers, e.g., ECGs, blood pressures,
- Hematologic data (CPT 99090);
- Gastric intubation (CPT 91105);
- Temporary transvenous pacing (CPT 92953);
- Ventilator management (CPT 94656, 94657, 94660, 94662); and
- Vascular access procedures (CPT 36000, 36410, 36600).

**HL7 Electronic Health Record Standard:** HL7 (Health Level 7) is an ANSI-accredited standards development organization, founded in 1987, in the healthcare domain. HL7 is a not-for-profit organization that develops standards for the management, integration, sharing, and exchange of clinical and administrative data supporting clinical practice and health service management.

```
<ClinicalDocument>
... CDA Header ...
<StructuredBody>
  <Section>
    <code code="101155-0" codeSystem="2.16.840.1.113883"
      codeSystemName="LOINC"/>
    <title> Allergies and Adverse Reaction </title>
    <text>
      <list>
        <item> Penicillin – Hives </item>
        <item> Aspirin – Wheezing </item>
        <item> Codeine – Itching and nausea </item>
      </list>
    </text>
    <observation classCode="OBS" moodCode="EVN">
      <entryRelationship typeCode="MFST">
        <observation classCode="OBS" moodCode="EVN">
          <code code="91936005" CodeSystem="2.16.840.1.113883"
            codeSystemName="SNOMED CT"/>
          </observation classCode="OBS" moodCode="EVN">
        </entryRelationship>
      </observation>
    </Section>
  </StructuredBody>
</ClinicalDocument>
```

**Figure 4- A sample CDA document, an example of allergies and adverse reaction**

*Source: HL7 Clinical Document Architecture, the Journal of the American Medical Information Association, Jan-Feb 2006*

The HL7 Clinical Document Architecture (CDA) is used to define standards for sharing and exchanging medical documents. The clinical contents of CDA documents are defined by using Reference Information Model (RIM) specification and data types. The HL7 standard development organization defines RIM as follows “The Reference Information Model (RIM) is the cornerstone of the HL7 Version 3 development process. An object model created as part of the Version 3 methodology, the

RIM is a large pictorial representation of the clinical data (domains) and identifies the life cycle of events that a message or groups of related messages will carry. It is a shared model between all the domains and as such is the model from which all domains create their messages. Explicitly representing the connections that exist between the information carried in the fields of HL7 messages, the RIM is essential to our ongoing mission of increasing precision and reducing implementation costs.” [17]

HL7 is currently engaged in providing the CDA that specifies the structure of clinical documents, such as a discharge summary, progress note, and procedure report. A CDA- based document is created by using an XML markup language and it can include data in different formats like text, image, audio, and other multimedia formats. Each CDA document is comprised of a header and a body section. The header of a CDA-based document identifies and classifies the document and provides information about the patient and healthcare provider. The body segment of a CDA document, which contains the clinical report, could have four different containers including: sections, paragraphs, lists, and tables (Figure 4) [18].

## **Conclusion**

The advantages of the NHIN over the current fragmented IT-based health systems are very obvious. Both health care consumers and providers will benefit from health care information sharing, exchange, and integration through NHIN. The implementation of a nationwide health information network will make patients’ health records available to all of health service providers, public health agencies, and health insurance companies in a secure digital format.

Even though the NHIN presents many benefits, there are, nevertheless, some important issues that must be addressed. The interaction between all healthcare providers - including hospitals, clinics, public health facilities, clinicians, and medical laboratories, and other health care related organizations -like health insurance companies, public health centers, and health care research institutes- necessitates wide interoperability. In other words, NHIN’s main goal is to enable all health care participants to communicate and recognize each other no matter which software, hardware, and communication technology they are using. This ambition will be met only if all IT-based health care systems conform to a set of uniform standards in the following areas:

- Medical terminology
- Medical classification
- Electronic Health Record (EHR)

Although far from being a panacea, the adoption and implementation of NHIN will contribute significantly to alleviate some of the problems besieging the U.S. health care system. Beyond technological measures, however, societal and political policies determine the future of the national health care system in the U.S.

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